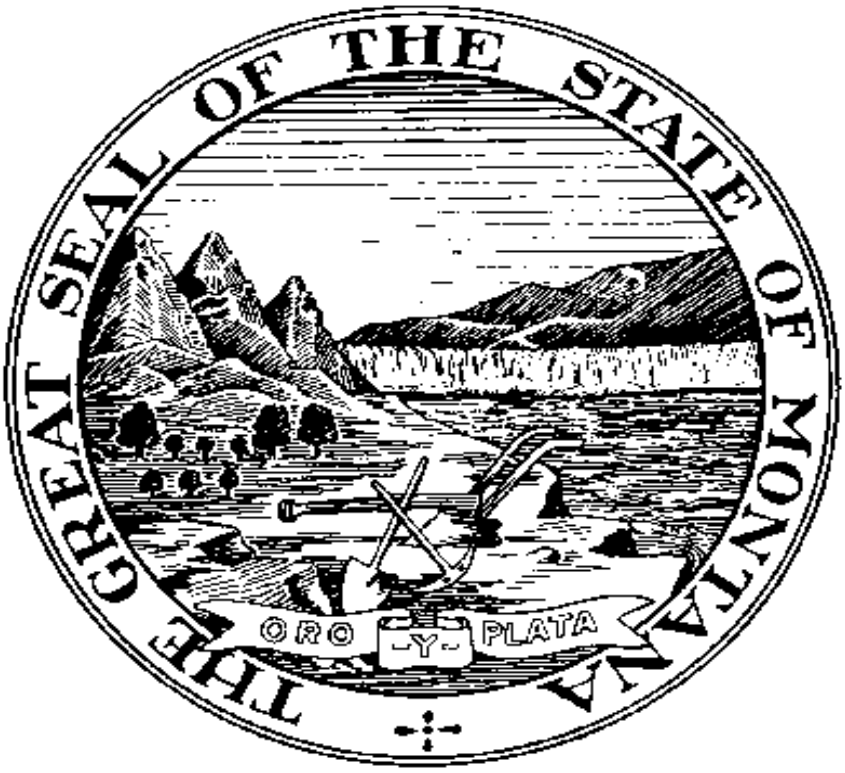
# Basic Guidelines
# For
# Equipment and Machine Guarding

Occupational Safety and Health Bureau




Montana Department of Labor & Industry

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Equipment and machines are common to nearly any type of industry. They are essential to providing the goods and services that make up our economy and support our society. However, they do not need to injure, maim, or kill and contribute to losses that ultimately add to the costs of goods and services we provide and enjoy. By applying basic principles of equipment and machine safeguarding, inspection, and maintenance we can avoid most accidents and still efficiently provide our goods and services.

Every employee is an important component of the production process, a process designed to run efficiently. When an employee is injured production capacity and the costs of operation are directly affected. An injury can cause the operator to be off the job for a long period of time, even permanently, requiring a replacement. Worker replacement can involve hiring, training, and lost productivity time, all of which represents costs to the employer.

Regardless of the amount of experience and training a person may have received, he or she can still be injured by a machine that is unguarded. Guarding reduces the likelihood that an accident will occur because of the things like mechanical failure, human error, electrical failure, or poor design.

The moving parts of equipment and machines can trap fingers, hands, feet, or other body parts. During various processes pieces of materials can be thrown and impact workers. Heat, gasses, and vapor may be produced during some processes. Simply moving materials can be a hazard. The energy source of equipment may be hazardous, whether electrical, pneumatic, hydraulic, or gravitational. These are all important things to consider in applying safeguarding principles.

To ensure that an operation is both safe and efficient, equipment hazards should be minimized or eliminated through good engineering in the design phase. Employees should also be trained to understand hazards and to take effective measures to control any hazards.

Where a hazard point cannot be eliminated it should be guarded. Often this requires measures as simple as providing a barrier between the worker and the hazard point.

The “point of operation” on equipment and machines is most often the greatest hazard because this is where the worker and machine are most closely associated. This is where a fixed barrier can be most effective by preventing the operator access to the hazard.

However, some activities can not be performed if a barrier guard is used. Part size, layout, or changes may make a barrier impractical. In such cases, alternate safeguarding may be necessary, allowing access between cycles.

A primary rule in safeguarding is that, the guarding of one hazard should not create another hazard.

Often safeguarding devices are used in combination with others. These include adjustable barriers, pull-out devices, mechanical restraints, presence sensing devices, and hand feeding tools.

There is a difference between guards and safeguarding. A guard will permanently prevent entry into a hazard point during normal operation, while safeguards restrict worker entry into hazard points. Guards should be removed only for authorized maintenance and repair, and only with proper lock-out tag-out procedures in place first. Guards should be replaced before the machine is returned to service. Safeguards are dependent on reliability of all of the system components, human and machine. Failure of either a human or machine safeguard component can result in an accident.

No guard or safeguard is completely safe. It either can be removed, disabled, or defeated if desired. Human error, haste, inattention and ignorance are the most common reasons for failure in a safeguarding program.

By educating and training employees, employers can provide the knowledge and understanding necessary to make a safeguarding program successful.

State and Federal regulations require that appropriate methods of machine guarding be provided to protect an operator and other employees in a machine area from hazards such as those created by nip points, rotating parts, flying chips, and sparks. The intent of these regulations is that the most suitable method of protection for the operator and other employees be provided and used.

It is also very important for an employer to perform regular and routine inspection and maintenance of equipment machines. Records of such inspection and maintenance should be kept and a copy made available in the event an authorized official request them.

Operator training should be provided and a record maintained indicating the type of training, it's content, and when it was conducted.

Basic rules for machine and equipment operation should include the following:

- No machine shall be operated by personnel other than those assigned and qualified to operate it.

- No machine shall be started until all guards are in place and are in good condition.

- Any missing or defective guard shall be reported to the supervisor at once.

- No guard shall be adjusted or removed for any reason by anyone, without supervisory authorization.

- Persons removing guards shall be trained in removal procedures, and shall follow required lock-out tag-out procedures.

- Employees are not permitted to work on or near any mechanical equipment while wearing loose clothing, neckties, unrestrained long hair, watches, rings, or other jewelry.

- Personal protective equipment must be worn by personnel during activities, and in areas, requiring it.

Some things to consider during inspections of equipment and facilities include the following:

- ❑ Is it possible for a person to come into direct contact with a moving machine part in normal production or maintenance operations?

- ❑ Are rotating or moving bolt heads, keys, screws, burns, or other projections so exposed as to snag a worker's clothing?

- ❑ Do equipment and/or machines have any reciprocating movements, or movement where workers can be caught on or between a moving part and a fixed object?

- ❑ Is it possible for a worker's hands or arms to make contact with moving parts at the point of operation where milling, shaping, punching, shearing, bending, grinding, or other work is being done?

- ❑ Is it possible for a worker to be drawn into the in-running nip point between two moving machine parts, such as a belt and sheave, a chain and sprocket, pressure rollers, a rack and gear, or a gear train?

- ❑ Is it possible for material (including dust or chips) to be kicked back or ejected from the point of operation and injure someone nearby?

- ❑ Are machine controls safeguarded to prevent unintended or inadvertent operation?

- ❑ Are machine controls located to provide immediate power cutoff in an emergency?

- ❑ Do machines vibrate, move or walk while in operation?
- ❑ Is it possible for parts to become loose during operation and fall onto personnel?
- ❑ Are machine guards positioned to correspond with the permissible openings between the bottom edge of the guard and feed table?
- ❑ Is it possible to bypass any guard so as to make it ineffective?
- ❑ Are machines placed so that operators have sufficient room to work with no exposure to aisle traffic?
- ❑ Is there sufficient room for maintenance and repair?
- ❑ Is there sufficient room to accommodate incoming materials, finished work, and scrap that is generated?
- ❑ Are materials handling methods adequate for the work process and the associated tooling?
- ❑ Are any associated tools, jigs, or other required work fixtures stored so as to be convenient yet not interfere with operations?
- ❑ Is the work area well illuminated with additional point of operation lighting as necessary?
- ❑ Is the area ventilation adequate, especially for operations creating dusts, mists, vapors, fumes, or gases?
- ❑ Is the operator using necessary personal protective equipment?
- ❑ Is the area housekeeping satisfactory with no debris, tripping or slipping hazards on the floor?

The following pages of materials are excerpted from the U.S. Department of Labor OSHA publication #3067 Concepts and Techniques of Machine Safeguarding. For more detailed information contact the Government Printing Office in Washington DC and reference ISBM 0-16-03792-5.

## CONCEPTS AND TECHNIQUES OF MACHINE SAFEGUARDING

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OSHA 3067 1992 (Revised)

### Introduction

This manual has been prepared as an aid to employers, employees, machine manufacturers, machine guard designers and fabricators, and all others with an interest in protecting workers against the hazards of moving machine parts. It identifies the major mechanical motions and the general principles of safeguarding them. Current applications of each technique are shown in accompanying illustrations of specific operations and machines. The methods described here may be transferred, with due care, to different machines with similar hazards. To determine whether or not safeguarding meets the requirements of the standard, any mechanical motion that threatens a worker's safety should not remain unguarded.

The approaches to machine safeguarding discussed in this manual are not the only solutions which meet the requirements of the standard. Why? Because practical solutions to safeguarding moving machine parts are as numerous as the people working on them. No publication could keep pace with all of these solutions or attempt to depict them all.

In machine safeguarding, as in other regulated areas of the American workplace, to a certain extent OSHA standards govern function and practice. This text, however, is not a substitute for the standards. It is a manual of basic technical information and workable ideas which the employer may use as a guide to achieve compliance. It offers an overview of the machine safeguarding problem in the industrial setting, an assortment of solutions in popular use, and a challenge to all whose work involves machines.

Many readers of this manual already have the judgment, knowledge, and skill to develop effective answers to problems yet unsolved. Innovators are encouraged to find here stimulation to eliminate mechanical hazards facing America's workers today.

## Chapter 1

## Basics of Machine Safeguarding

Crushed hands and arms, severed fingers, blindness -- the list of possible machinery-related injuries is as long as it is horrifying. There seem to be as many hazards created by moving machine parts as there are types of machines. Safeguards are essential for protecting workers from needless and preventable injuries.

A good rule to remember is: Any machine part, function, or process which many cause injury must be safeguarded. When the operation of a machine or accidental contact with it can injure the operator or others in the vicinity, the hazards must be either controlled or eliminated.

This manual describes the various hazards of mechanical motion and presents some techniques for protecting workers from these hazards. General information covered in this chapter includes -- where mechanical hazards occur, the hazards created by different kinds of motions and the requirements for effective safeguards, as well as a brief discussion of nonmechanical hazards.

## Where Mechanical Hazards Occur

Dangerous moving parts in three basic areas require safeguarding:
The point of operation: that point where work is performed on the material, such as cutting, shaping, boring, or forming of stock.
Power transmission apparatus: all components of the mechanical system which transmit energy to the part of the machine performing the work. These components include flywheels, pulleys, belts, connecting rods, couplings, cams, spindles, chains, cranks, and gears.

Other moving parts: all parts of the machine which move while the machine is working. These can include reciprocating, rotating, and transverse moving parts, as well as feed mechanisms and auxiliary parts of the machine.

## Hazardous Mechanical Motions and Actions

A wide variety of mechanical motions and actions may present hazards to the worker. These can include the movement of rotating members, reciprocating arms, moving belts, meshing gears, cutting teeth, and any parts that impact or shear. These different types of hazardous mechanical motions and actions are basic in varying combinations to nearly all machines, and recognizing them is the first step toward protecting workers from the danger they present.

The basic types of hazardous mechanical motions and actions are:

### Motions

- rotating (including in-running nip points)
- reciprocating
- transverse

**Actions**

- cutting
- punching
- shearing
- bending

We will briefly examine each of these basic types in turn.

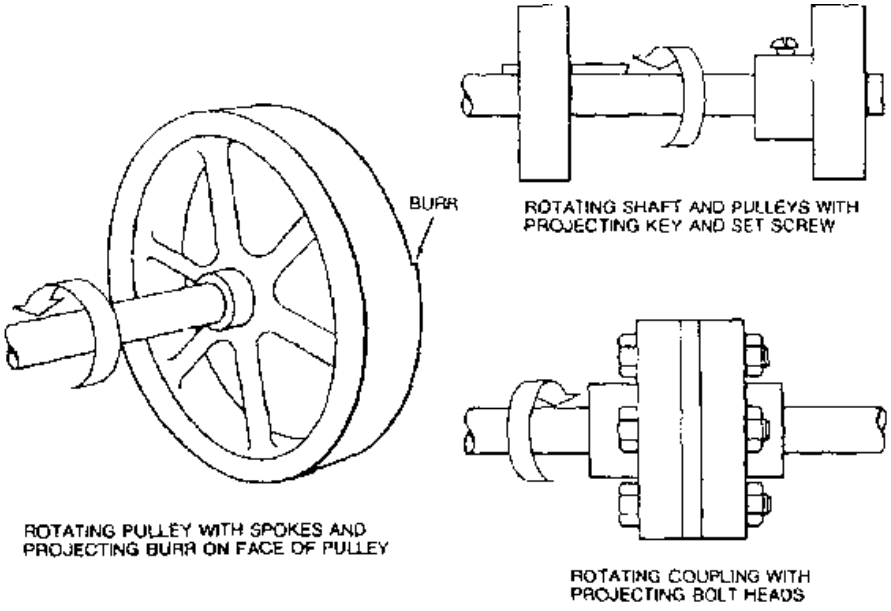
**Motions**

Rotating motion can be dangerous; even smooth, slowly rotating shafts can grip clothing, and through mere skin contact force an arm or hand into a dangerous position. Injuries due to contact with rotating parts can be severe.

Collars, couplings, cams, clutches, flywheels, shaft ends, spindles, meshing gears, and horizontal or vertical shafting are some examples of common rotating mechanisms which may be hazardous. The danger increases when projections such as set screws, bolts, nicks, abrasions, and projecting keys or set screws are exposed on rotating parts, as shown in Figure 1.

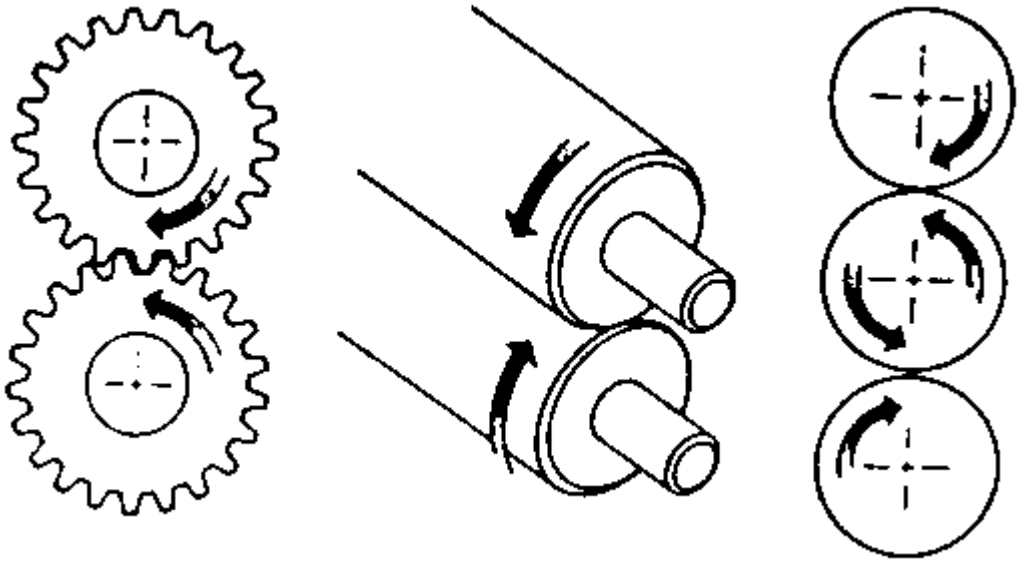
In-running nip point hazards are caused by the rotating parts on machinery. There are three main types of in-running nips.

**Figure 1.**




Parts can rotate in opposite directions while their axes are parallel to each other. These parts may be in contact (producing a nip point) or in close proximity. In the latter case the stock fed between the rolls produces the nip points. This danger is common on machines with intermeshing gears, rolling mills, and calenders. See Figure 2.

**Figure 2. Common Nip Points On Rotating Parts**



Nip points are also created between rotating and tangentially moving parts. Some examples would be: the point of contact between a power transmission belt and its pulley, a chain and a sprocket, and a rack and pinion. See Figure 3.

Nip points can occur between rotating and fixed parts which create a shearing, crushing, or abrading action. Examples are: spoked handwheels or flywheels, screw conveyors, or the periphery of an abrasive wheel and an incorrectly adjusted work rest. See Figure 4.

**Figure 3. Nip points between rotating elements and parts with longitudinal motions.**

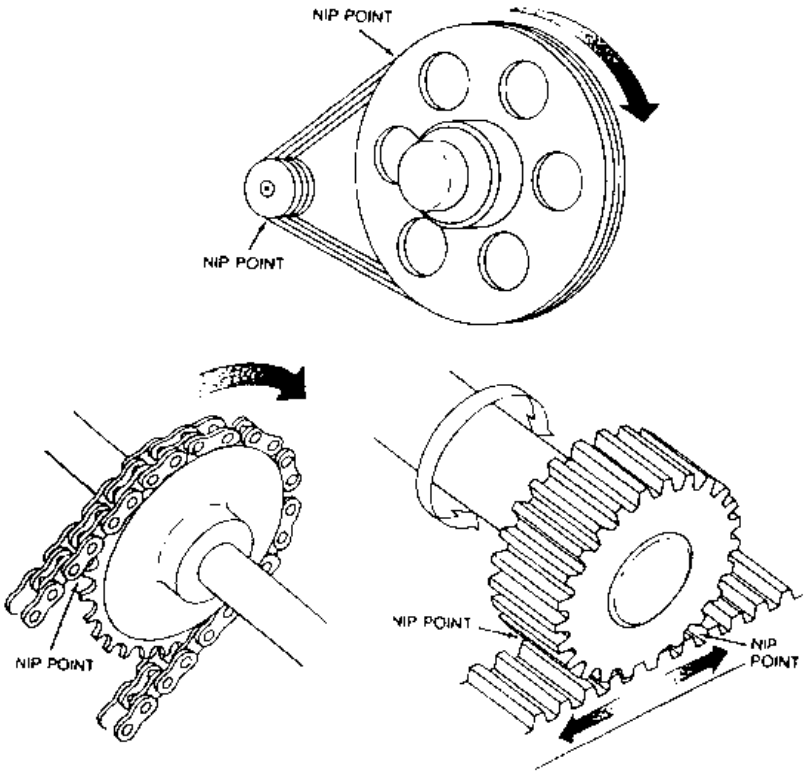



**Figure 4. Nip points between rotating machine components;**
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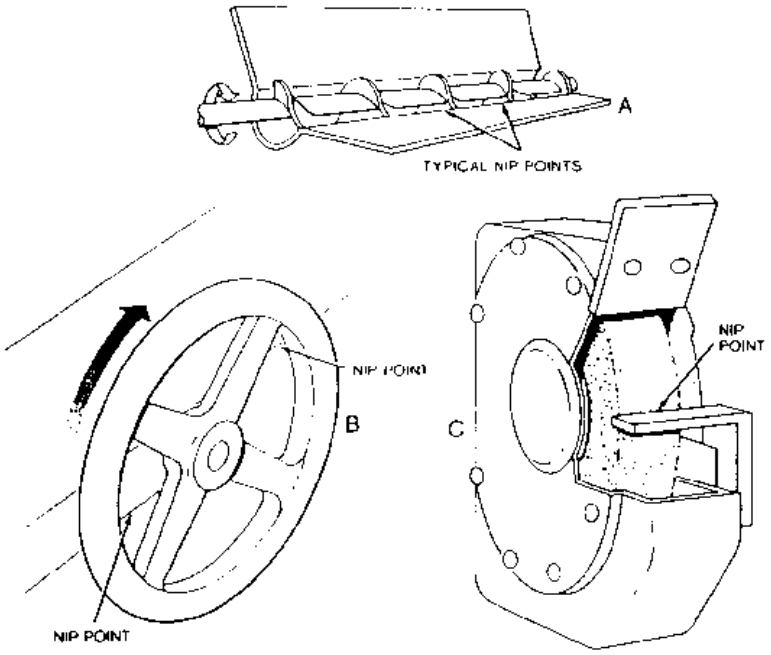
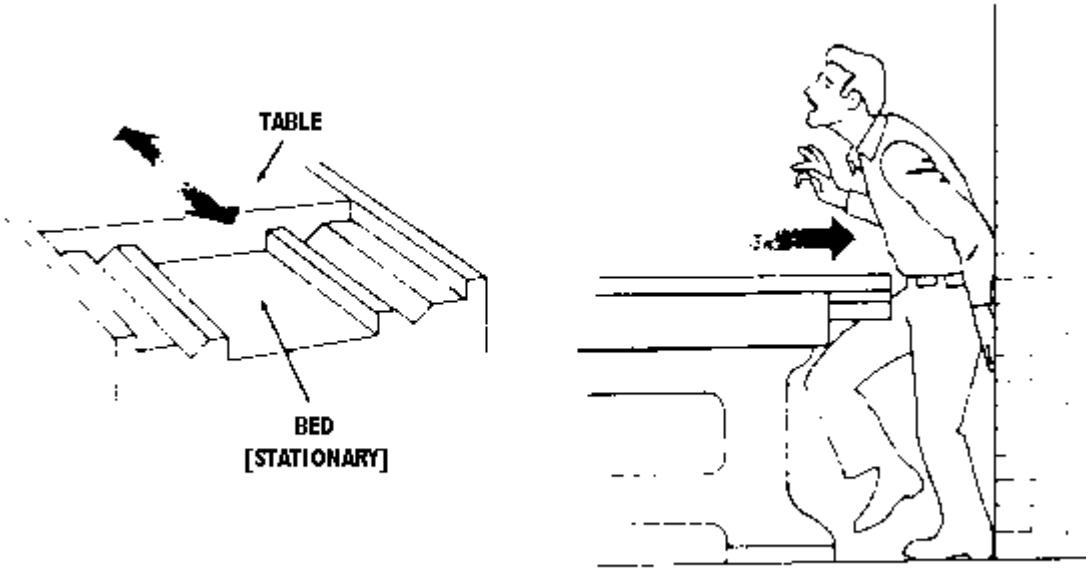


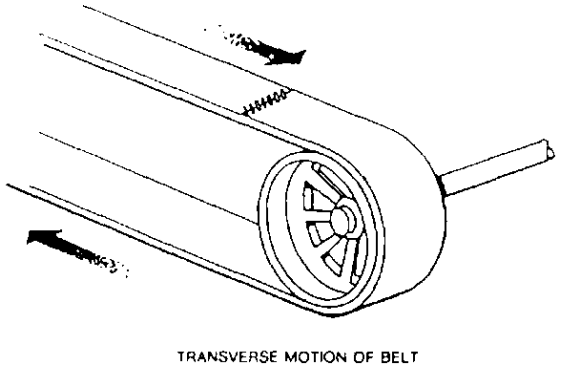
Reciprocating motions may be hazardous because, during the back-and-forth or up-and-down motion, a worker may be struck by or caught between a moving and a stationary part. See Figure 5. for an example of a reciprocating motion.

**Figure 5. Hazardous reciprocating motion.**




Transverse motion (movement in a straight, continuous line) creates a hazard because a worker may be struck or caught in a pinch or shear point by the moving part. See Figure 6.

**Figure 6. Example of transverse motion**.

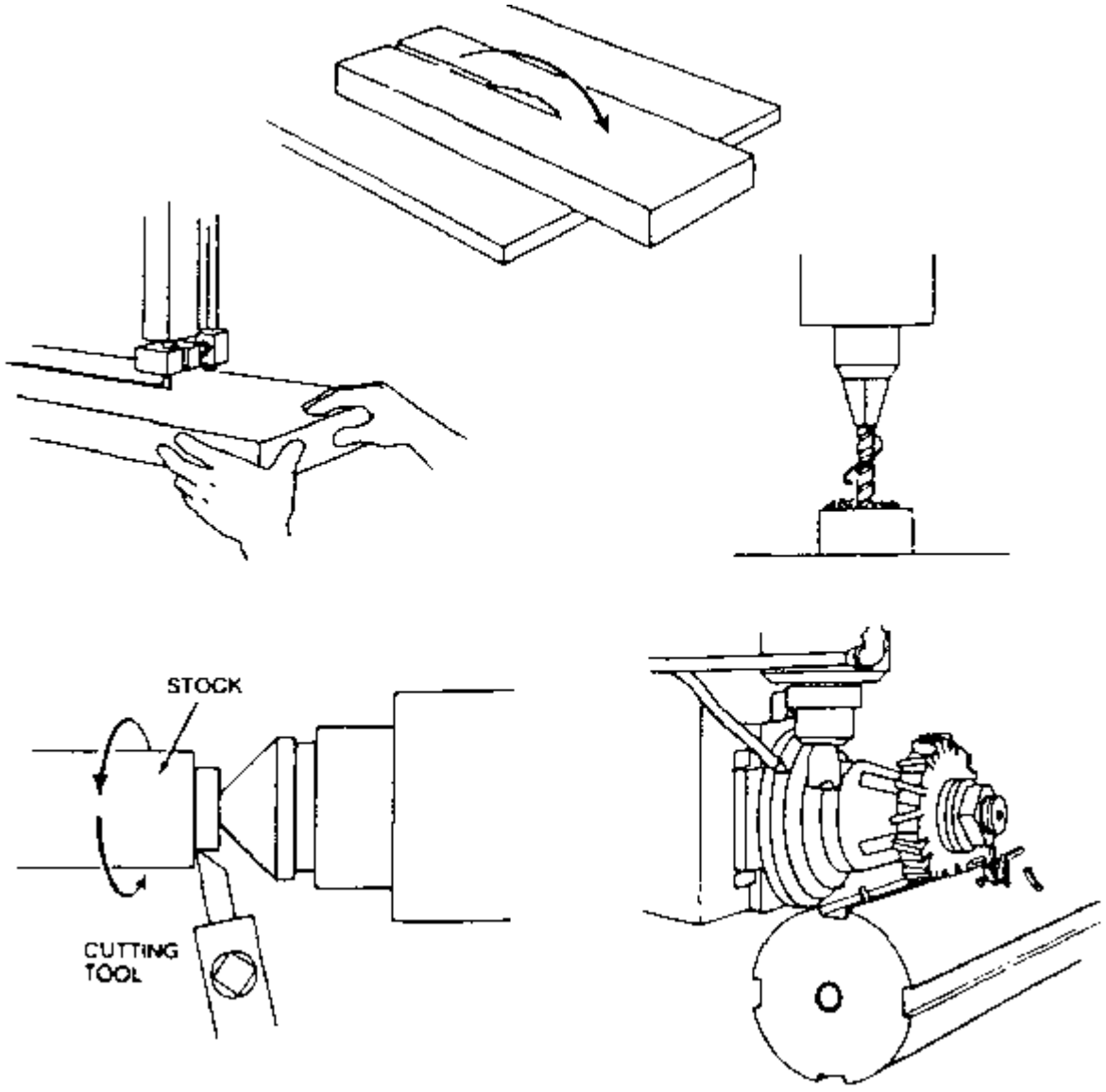


**Actions**

Cutting action may involve rotating, reciprocating, or transverse motion. The danger of cutting action exists at the point of operation where finger, arm and body injuries can occur and where flying chips or scrap material can strike the head, particularly in the area of the eyes or face. Such hazards are present at the point of operation in cutting wood, metal, or other materials.

Examples of mechanisms involving cutting hazards include bandsaws, circular saws, boring or drilling machines, turning machines (lathes), or milling machines. See Figure 7.

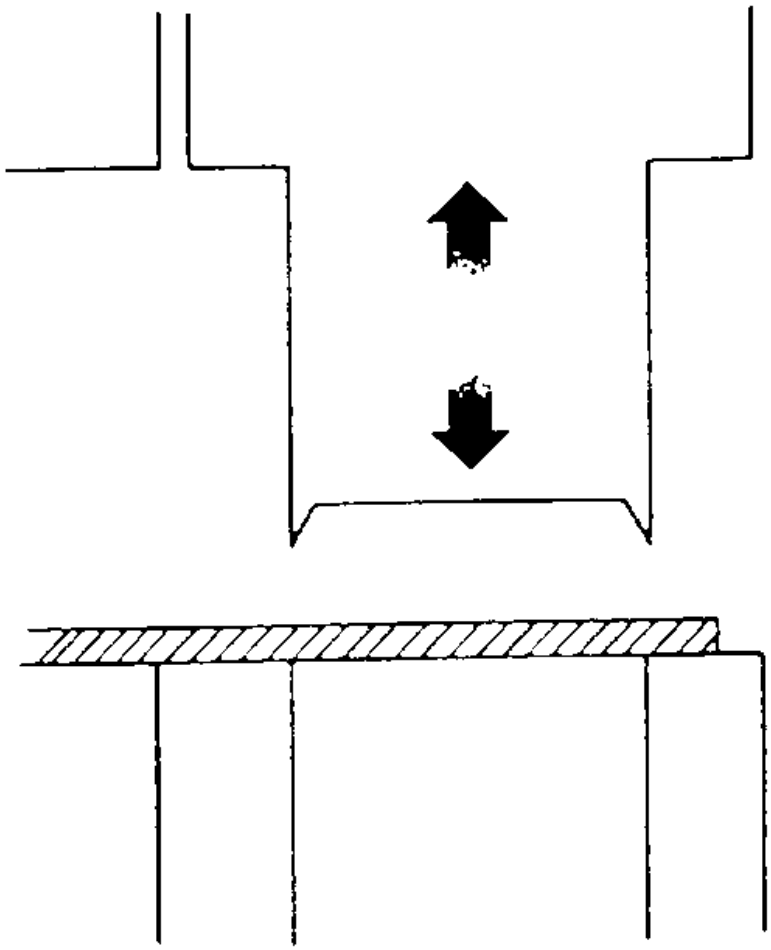
**Figure 7. Examples of dangerous cutting hazards.**



Punching action results when power is applied to a slide (ram) for the purpose of blanking, drawing, or stamping metal or other materials. The danger of this type of action occurs at the point of operation where stock is inserted, held, and withdrawn by hand.

Typical machines used for punching operations are power presses and iron workers. See Figure 8.

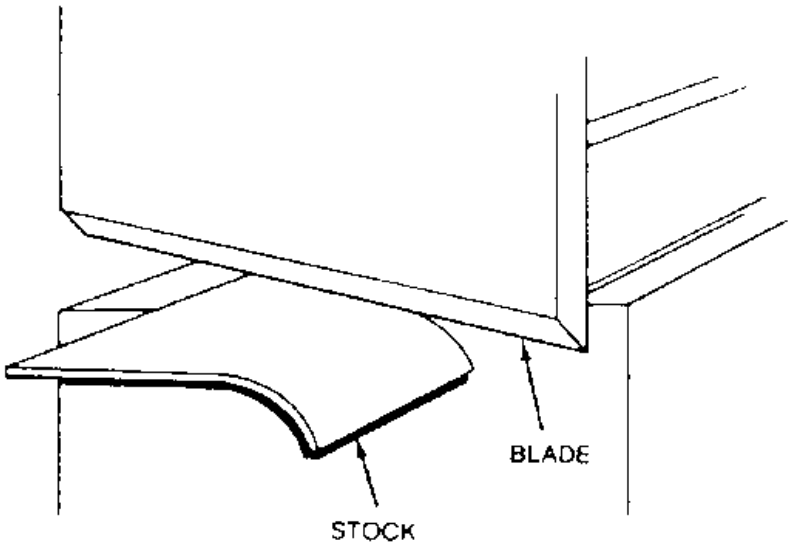
**Figure 8. Typical punching operation.**



Shearing action involves applying power to a slide or knife in order to trim or shear metal or other materials. A hazard occurs at the point of operation where stock is actually inserted, held, and withdrawn.

Examples of machines used for shearing operations are mechanically, hydraulically, or pneumatically powered shears. See Figure 9.

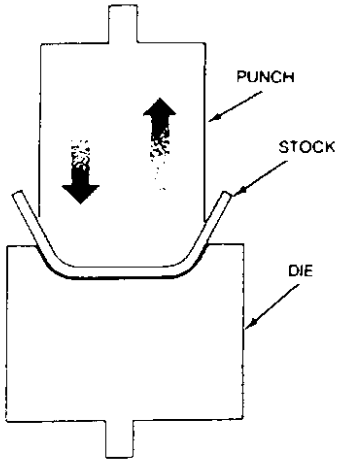
**Figure 9. Shearing**




Bending action results when power is applied to a slide in order to draw or stamp metal or other materials. A hazard occurs at the point of operation where stock is inserted, held, and withdrawn.

Equipment that uses bending action includes power presses, press brakes, and tubing benders. See Figure 10.

**Figure 10. Bending**



## Requirements for Safeguards

What must a safeguard do to protect workers against mechanical hazards? Safeguards must meet these minimum general requirements:

*Prevent contact:* The safeguard must prevent hands, arms, and any other part of a worker's body from making contact with dangerous moving parts. A good safeguarding system eliminates the possibility of the operator or another worker placing parts of their bodies near hazardous moving parts.

*Secure:* Workers should not be able to easily remove or tamper with the safeguard, because a safeguard that can easily be made ineffective is no safeguard at all. Guards and safety devices should be made of durable material that will withstand the conditions of normal use. They must be firmly secured to the machine.

*Protect from falling objects:* The safeguard should ensure that no objects can fall into moving parts. A small tool which is dropped into a cycling machine could easily become a projectile that could strike and injure someone.

*Create no new hazards:* A safeguard defeats its own purpose if it creates a hazard of its own such as a shear point, a jagged edge, or an unfinished surface which can cause a laceration. The edges of guards, for instance, should be rolled or bolted in such a way that they eliminate sharp edges.

*Create no interference:* Any safeguard which impedes a worker from performing the job quickly and comfortably might soon be overridden or disregarded. Proper safeguarding can actually enhance efficiency since it can relieve the worker's apprehensions about injury.

*Allow safe lubrication:* If possible, one should be able to lubricate the machine without removing the safeguards. Locating oil reservoirs outside the guard, with a line leading to the lubrication point, will reduce the need for the operator or maintenance worker to enter the hazardous area.

## Nonmechanical Hazards

While this manual concentrates attention on concepts and techniques for safeguarding mechanical motion, machines obviously present a variety of other hazards which cannot be ignored. Full discussion of these matters is beyond the scope of this publication, but some nonmechanical hazards are briefly mentioned below to remind the reader of things other than safeguarding moving parts that can affect the safe operation of machines.

All power sources for machines are potential sources of danger. When using electrically powered or controlled machines, for instance, the equipment as well as the electrical system itself must be properly grounded. Replacing frayed, exposed, or old wiring will also help to protect the operator and others from electrical shocks or electrocution. High pressure systems, too, need careful inspection and maintenance to prevent possible failure from pulsation, vibration, or leaks. Such a failure could cause, among other things, explosions or flying objects.

Machines often produce noise (unwanted sound) which can result in a number of hazards to workers. Noise can startle and disrupt concentration, and can interfere with communications, thus hindering the worker's safe job performance. Research has linked noise to a whole range of harmful health effects, from hearing loss and aural pain to nausea, fatigue, reduced muscle control, and emotional disturbance. Engineering controls such as the use of sound-dampening materials, and personal protective equipment, such as earplugs and muffs, can help control the harmful effects of noise. Also, administrative controls that involve removing the worker from the noise source can be an effective measure when feasible.

Because some machines require the use of cutting fluids, coolants, and other potentially harmful substances, operators, maintenance workers, and others in the vicinity may need protection. These substances can cause ailments ranging from dermatitis to serious illnesses and disease. Specially constructed safeguards, ventilation, and protective equipment and clothing are possible temporary solutions to the problem of machinery-related chemical hazards until these hazards can be better controlled or eliminated from the workplace.

## Training

Even the most elaborate safeguarding system cannot offer effective protection unless the worker knows how to use it and why. Specific and detailed training is therefore a crucial part of any effort to provide safeguarding against machine-related hazards. Thorough operator training should involve instruction or hands-on training in the following:

1) a description and identification of the hazards associated with particular machines;

2) the safeguards themselves, how they provide protection, and the hazards for which they are intended;

3) how to use the safeguards and why;
4) how and under what circumstances safeguards can be removed, and by whom (in most cases, repair or maintenance personnel only); and

5) what to do (e.g., contact the supervisor) if a safeguard is damaged, missing, or unable to provide adequate protection.

This kind of safety training is necessary for new operators and maintenance or setup personnel, when any new or altered safeguards are put in service, or when workers are assigned to a new machine or operation.

### Protective Clothing and Personal Protective Equipment

Engineering controls that eliminate the hazard at the source and do not rely on the worker's behavior for their effectiveness offer the best and most reliable means of safeguarding. Therefore, engineering controls must be the employer's first choice for eliminating machine hazards. But whenever engineering controls are not available or are not fully capable of protecting the employee (an extra measure of protection is necessary), operators must wear protective clothing or personal protective equipment.

If it is to provide adequate protection, the protective clothing and equipment selected must always be:

(1) appropriate for the particular hazards;
(2) maintained in good condition;
(3) properly stored when not in use, to prevent damage or loss; and
(4) kept clean, fully functional, and sanitary.

Protective clothing is, of course, available for different parts of the body. Hard hats can protect the head from the impact of bumps and falling objects when the worker is handling stock; caps and hair nets can help keep the worker's hair from being caught in machinery. If machine coolants could splash or particles could fly into the operator's eyes or face, then face shields, safety goggles, glasses, or similar kinds of protection might be necessary. Hearing protection may be needed when workers operate noisy machines. To guard the trunk of the body from cuts or impacts from heavy or rough-edged stock, there are certain protective coveralls, jackets, vests, aprons, and full-body suits. Workers can protect their hands and arms from the same kinds of injury with special sleeves and gloves. Safety shoes and boots, or other acceptable foot guards, can shield the feet against injury in case the worker needs to handle heavy stock which might drop.

It is important to note that protective clothing and equipment can create hazards. A protective glove which can become caught between rotating parts, or a respirator facepiece which hinders the wearer's vision, for example, require alertness and continued attentiveness whenever they are used.

Other parts of the worker's clothing may present additional safety hazards. For example, loose-fitting shirts might possibly become entangled in rotating spindles or other kinds of moving machinery. Jewelry, such as bracelets and rings, can catch on machine parts or stock and lead to serious injury by pulling a hand into the danger area.

## Chapter 2

## Methods of Machine Safeguarding

There are many ways to safeguard machines. The type of operation, the size or shape of stock, the method of handling, the physical layout of the work area, the type of material, and production requirements or limitations will help to determine the appropriate safeguarding method for the individual machine.

As a general rule, power transmission apparatus is best protected by fixed guards that enclose the danger areas. For hazards at the point of operation, where moving parts actually perform work on stock, several kinds of safeguarding may be possible. One must always choose the most effective and practical means available.

We can group safeguards under five general classifications.

1. Guards
   - A. Fixed
   - B. Interlocked
   - C. Adjustable
   - D. Self-adjusting

2. Devices
   - A. Presence Sensing
     - (1) Photoelectrical (optical)
     - (2) Radiofrequency (capacitance)
     - (3) Electromechanical
   - B. Pullback
   - C. Restraint
   - D. Safety Controls
     - (1) Safety trip control
       - (a) Pressure-sensitive body bar
       - (b) Safety tripod
       - (c) Safety tripwire cable
     - (2) Two-hand control
     - (3) Two-hand trip
   - E. Gates
     - (1) Interlocked
     - (2) Other

3. Location/Distance

4. Potential Feeding and Ejection Methods to Improve Safety for the Operator
   - A. Automatic feed
   - B. Semi-automatic feed
   - C. Automatic ejection
   - D. Semi-automatic ejection

E. Robot

5. Miscellaneous Aids
   A. Awareness barriers
   B. Miscellaneous protective shields
   C. Hand-feeding tools and holding fixtures

## Guards

Guards are barriers which prevent access to danger areas. There are four general types of guards:

**GUARDS**

| Method | Safeguarding Action | Advantages | Limitations |
|---|---|---|---|
| Fixed | Provides a barrier | Can be constructed to suit many specific applications.<br><br>In-plant construction is often possible.<br><br>Can provide maximum protection.<br><br>Usually requires minimum maintenance.<br><br>Can be suitable to high production, repetitive operations. | May interfere with visibility.<br><br>Can be limited to specific operations<br><br>Machine adjustment and repair often require its removal, thereby necessitating other means of protection for maintenance personnel. |
| Interlocked | Shuts off or disengages power and prevents starting of machine when guard is open; should require the machine to be stopped before the worker can reach into the danger area. | Can provide maximum protection.<br><br>Allows access to machine for removing jams without time-consuming removal of fixed guards. | Requires careful adjustment and maintenance.<br><br>May be easy to disengage. |
| Adjustable | Provides a barrier which may be adjusted to facilitate a variety of production operations. | Can be constructed to suit many specific operations.<br><br>Can be adjusted to admit varying sizes of stock. | Hands may enter area-protection may not be complete at all times.<br><br>May require frequent maintenance and/or adjustment.<br><br>The guard may be made ineffective by the operator.<br><br>May interfere with visibility. |
| Self-adjusting | Provides a barrier which moves according to the size of the stock entering danger area. | Off-the-self guards are often commercially available. | Does not always provide maximum protection.<br><br>May interfere with visibility.<br><br>May require frequent maintenance and adjustment. |

## Devices

**DEVICES**

| **Method** | **Safeguarding Action** | **Advantages** | **Limitations** |
|---|---|---|---|
| Photoelectric (optical) | Machine will not start cycling when the light field is | Can allow freer movement for | Does not protect against mechanical failure. |

| | | | |
|---|---|---|---|
| | interrupted.<br><br>When the light field is broken by any part of the operator's body during the cycling process, immediate machine braking is activated. | operator. | May require frequent alignment and calibration.<br>Excessive vibration may cause lamp filament damage and premature burnout.<br>Limited to machines that can be stopped. |
| Radiofrequency (capacitance) | Machine cycling will not start when the capacitance field is interrupted.<br>When the capacitance field is disturbed by any part of the operator's body during the cycling process, immediate machine braking is activated. | Can allow freer movement for operator. | Does not protect against mechanical failure.<br><br>Antennae sensitivity must be properly adjusted.<br><br>Limited to machines that can be stopped. |
| Electromechanical | Contact bar or probe travels a predetermined distance between the operator and the danger area.<br>Interruption of this movement prevents the starting of machine cycle. | Can allow access at the point of operation | Contact bar or probe must be properly adjusted for each application; this adjustment must be maintained properly. |
| Pullback | As the machine begins to cycle, the operator's hands are pulled out of the danger area. | Eliminates the need for auxiliary barriers or other interference at the danger area. | Limits movement of operator.<br>May obstruct work-space around operator.<br>Adjustments must be made for specific operations and for each individual.<br>Requires frequent inspections and regular maintenance.<br>Requires close supervision of the operator's use of the equipment. |
| Restraint (holdback) | Prevents the operator from reaching into the danger area. | Little risk of mechanical failure. | Limits movements of operator.<br>May obstruct work-space.<br>Adjustments must be made for specific operations and each individual.<br>Requires close supervision of the operator's use of the equipment. |

## Devices

| Method | Safeguarding | Advantages | Limitations |
|---|---|---|---|
| Safety trip controls:<br>Pressure sensitive body bar<br>Safety triprod<br>Safety tripwire | Stop machine when tripped | Simplicity of use | All controls must be manually activated.<br><br>May be difficult to activate controls because of their location.<br><br>Only protects the operator<br><br>May require special fixtures |

| | | | |
|---|---|---|---|
| | | | to hold work.<br><br>May require a machine brake. |
| Two-hand control | Concurrent use of both hands is required, preventing the operator from entering the danger area. | Operator's hands are at a predetermined location.<br><br>Operator's hands are free to pick up a new part after first half of cycle is completed. | Requires a partial cycle machine with a brake.<br><br>Some two-hand controls can be rendered unsafe by holding with arm or blocking, thereby permitting one-hand operation.<br>Protects only the operator. |
| Two-hand trip | Concurrent use of both hands on separate controls prevents hands from being in danger area when machine cycle starts. | Operator's hands are away from danger area.<br><br>Can be adapted to multiple operations.<br><br>No obstruction to hand feeding.<br><br>Does not require adjustment for each operation. | Operator may try to reach into danger area after tripping machine.<br>Some trips can be rendered unsafe by holding with arm or blocking, thereby permitting one-hand operation.<br>Protects only the operator.<br>May require special fixtures. |
| Gate | Provides a barrier between danger area and operator or other personnel | Can prevent reaching into or walking into the danger area. | May require frequent inspection and regular maintenance.<br><br>May interfere with operator's ability to see the work. |

## Safeguarding by Location/Distance

The examples mentioned below are a few of the numerous applications of the principle of safeguarding by location/distance. A thorough hazard analysis of each machine and particular situation is absolutely essential before attempting this safeguarding technique.

To consider a part of a machine to be safeguarded by location, the dangerous moving part of a machine must be so positioned that those areas are not accessible or do not present a hazard to a worker during the normal operation of the machine. This may be accomplished by locating a machine so that the hazardous parts of the machine are located away from operator workstations or other areas where employees walk or work. This can be accomplished by positioning a machine with its power transmission apparatus against a wall and leaving all routine operations conducted on the other side of the machine.

Additionally, enclosure walls or fences can restrict access to machines. Another possible solution is to have dangerous parts located high enough to be out of the normal reach of any worker.

The feeding process can be safeguarded by location if a safe distance can be maintained to protect the worker's hands. The dimensions of the stock being worked on may provide adequate safety.

For instance, if the stock is several feet long and only one end of the stock is being worked on, the operator may be able to hold the opposite end while the work is being performed. An example would be a single-end-punching machine. However, depending upon the machine, protection might still be required for another personnel.

The positioning of the operator's control station provides another potential approach to safeguarding by location. Operator controls may be located at a safe distance from the machine if there is no reason for the operator to tend it.

## Feeding the Ejection Methods to Improve Operator Safety

Many feeding and ejection methods do not require the operator to place his or her hands in the danger area. In some cases, no operator involvement is necessary after the machine is set up. In other situations, operators can manually feed the stock with the assistance of a feeding mechanism. Properly designed ejection methods do not require any operator involvement after the machine starts to function.

Some feeding and ejection methods may even create hazards themselves. For instance, a robot may eliminate the need for an operator to be near the machine but may create a new hazard itself by the movement of its arm.

Using these feeding and ejection methods does not eliminate the need for guards and devices. Guards and devices must be used wherever they are necessary and possible in order to provide protection from exposure to hazards.

## Miscellaneous Aids

While these aids do not give complete protection from machine hazards, they may provide the operator with an extra margin of safety. Sound judgment is needed in their application and usage.

Below are several examples of possible applications.

## Awareness barrier

An awareness barrier does not provide physical protection, but serves only to remind a person that he or she is approaching the danger area. Generally, awareness barriers are not considered adequate when continual exposure to the hazard exists.

Although the barrier does not physically prevent a person

from entering the danger area, it calls attention to it. For an employee to enter the danger area, an overt act must take place, that is, the employee must either reach or step over, under or through the barrier.

### Shields

Shields, another aid, may be used to provide protection from flying particles, splashing cutting oils, or coolants.

### Holding tools

Special hand tools may be used to place or remove stock, particularly from or into the point of operation of a machine. A typical use would be for reaching into the danger area of a press or press brake. Holding tools should not be used instead of other machine safeguards; they are merely a supplement to the protection that other guards provide.

### Push sticks

A push stick or block may be used when feeding stock into a saw blade. When it becomes necessary for hands to be in close proximity to the blade, the push stick or block may provide a few inches of safety and prevent a severe injury.

## Chapter 3

### Guard Construction

Today many builders of single-purpose machines provide point-of-operation and power transmission safeguards as standard equipment. However, not all machines in use have built-in safeguards provided by the manufacturer.

Guards designed and installed by the builder offer two main advantages:

- They usually conform to the design and function of the machine.
- They can be designed to strengthen the machine in some way or to serve some additional functional purposes.

User-built guards are sometimes necessary for a variety of reasons. They have these advantages:

- Often, with older machinery, they are the only practical safeguarding solution.
- They may be the only choice for mechanical power transmission apparatus in older plants, where machinery is not powered by individual motor drives.

- They permit options for point-of-operation safeguards when skilled personnel design and make them.

- They can be designed and built to fit unique and even changing situations.

- They can be installed on individual dies and feeding mechanisms.

- Design and installation of machine safeguards by plant personnel can help to promote safety consciousness in the workplace.

However, they also have disadvantages:

- User-built guards may not conform well to the configuration and function of the machine.

- There is a risk that user-built guards may be poorly designed or built.

**Point-of-Operation Guards**

Point-of-operation safeguarding is complicated by the number and complexity of machines and also by the different uses for individual machines. For these reasons, not all machine builders provide point-of-operation guards on their products. In many cases a point-of-operation guard can only be made and installed by the user after a thorough hazard analysis of the work requirements. Poorly designed, built or installed guards may create a hazard rather than eliminate one. To be effective they must safeguard the employee while allowing the work to continue with minimum disruption to the production process.

**Mechanical Power Transmission Apparatus Guarding**

A significant difference between power transmission guards and point-of-operation guards is that the former type needs no opening for feeding stock. The only openings necessary for power transmission guards are those for lubrication, adjustment, repair, and inspection. These openings should be provided with interlocked covers that cannot be removed except by using tools for service or adjustment.

To be effective, power transmission guards should cover all moving parts in such a manner that no part of the operator's body can come in contact with them.

**Guard Material**

Under many circumstances, metal is the best material for guards. Guard framework is usually made from structural shapes, pipe, bar, or rod stock. Filler material generally is

expanded or perforated or solid sheet metal or wire mesh. It may be feasible to use plastic or safety glass where visibility is required.

Guards made of wood generally are not recommended because of their flammability and lack of durability and strength. However, in areas where corrosive materials are present, wooden guards may be the better choice.

# Chapter 4

## Machinery Maintenance and Repair

Good maintenance and repair procedures contribute significantly to the safety of the maintenance crew as well as that of machine operators. The variety and complexity of machines to be serviced, the hazards associated with their power sources, the special dangers that may be present during machine breakdown, and the severe time constraints often placed on maintenance personnel all make safe maintenance and repair work difficult.

Training and aptitude of people assigned to these jobs should make them alert for the intermittent electrical failure, the worn part, the inappropriate noise, the cracks or other signs that warn of impending breakage or that a safeguard has been damaged, altered, or removed. By observing machine operators at their tasks and listening to their comments, maintenance personnel may learn where potential trouble spots are and give them early attention before they develop into sources of accidents and injury. Sometimes all that is needed to keep things running smoothly and safely is machine lubrication or adjustment.

Any damage observed or suspected should be reported to the supervisor; if the condition impairs safe operation, the machine should be out of service for repair. Safeguards that are missing, altered, or damaged also should be reported so appropriate action can be taken to insure against worker injury.

If possible, machine design should permit routine lubrication and adjustment without removal of safeguards. But when safeguards must be removed, and the machine serviced, the lockout procedure of 29 CFR 1910.147 must be adhered to. The maintenance and repair crew must never fail to replace the guards before the job is considered finished and the machine released from lockout.

Is it necessary to oil machine parts while a machine is running? If so, special safeguarding equipment may be needed solely to protect the oiler from exposure to hazardous moving parts. Maintenance personnel must know which machines can be serviced while running and which cannot. "If in doubt, lock it out." Obviously, the danger of accident or injury is reduced by shutting off and locking out all sources of energy.

In situations where the maintenance or repair worker would necessarily be exposed to electrical elements or hazardous moving machine parts in the performance of the job, there is no question that all power sources must be shut off and locked out

before work begins. Warning signs or tags are inadequate insurance against the untimely energizing of mechanical
equipment.

Thus, one of the first procedures for the maintenance person is to disconnect and lock out the machine from all of its power sources, whether the source is electrical, mechanical, pneumatic, hydraulic, or a combination of these. Energy accumulation devices must be "bled down."

## Machine Guarding Checklist

Answers to the following questions should help the interested reader determine the safeguarding needs of his or her own workplace, by drawing attention to hazardous conditions or practices requiring correction.

### Requirements for all Safeguards

| | Yes | No |
|---|---|---|
| 1. Do the safeguards provided meet the minimum OSHA requirements? | ____ | ____ |
| 2. Do the safeguards prevent workers' hands, arms, and other? body parts for making contact with dangerous moving parts? | ____ | ____ |
| 3. Are the safeguards firmly secured and not easily removable? | ____ | ____ |
| 2. Do the safeguards ensure that no object will fall into the moving parts? | ____ | ____ |
| 3. Do the safeguards permit safe, comfortable, and relatively easy operation of the machine? | ____ | ____ |
| 6. Can the machine be oiled without removing the safeguard? | ____ | ____ |
| 7. Is there a system for shutting down the machinery before safeguards are removed? | ____ | ____ |
| 8. Can the existing safeguards be improved? | ____ | ____ |

### Mechanical Hazards

The point of operation:

| | | |
|---|---|---|
| 1. Is there a point-of-operation safeguard provided for the machine? | ____ | ____ |
| 2. Does it keep the operator's hands, fingers, body out of the danger area? | ____ | ____ |
| 3. Is there evidence that the safeguards have been tampered with or removed? | ____ | ____ |
| 4. Could you suggest a more practical, effective safeguard? | ____ | ____ |
| 5. Could changes be made on the machine to eliminate the point-of-operation hazard entirely? | ____ | ____ |

Power transmission apparatus:

| | | |
|---|---|---|
| 1. Are there any unguarded gears, sprockets, pulleys, or flywheels on the apparatus? | ____ | ____ |
| 2. Are there any exposed belts or chain drives? | ____ | ____ |
| 3. Are there any exposed set screws, key ways, collars, etc.? | ____ | ____ |
| 4. Are starting and stopping controls within easy reach of the operator? | ____ | ____ |
| 5. If there is more than one operator, are separate controls provided? | ____ | ____ |

| | Yes | No |
|---|---|---|

Other moving parts:

1. Are safeguards provided for all hazardous moving parts of the machine including auxiliary parts? ____ ____

## Nonmechanical Hazards

1. Have appropriate measures been taken to safeguard workers against noise hazards? ____ ____
2. Have special guards, enclosures, or personal protective equipment been provided, where necessary, to protect workers from exposure to harmful substances used in machine operation? ____ ____

## Electric Hazards

1. Is the machine installed in accordance with National Fire Protection Association and National Electrical Code requirements? ____ ____
2. Are there loose conduit fittings? ____ ____
3. Is the machine properly grounded? ____ ____
4. Is the power supply correctly fused and protected? ____ ____
5. Do workers occasionally receive minor shocks while operating any of the machines? ____ ____

## Training

1. Do operators and maintenance workers have the necessary training in how to use the safeguards and why? ____ ____
2. Have operators and maintenance workers been trained in where the safeguards are located, how they provide protection, and what hazards they protect against? ____ ____
3. Have operators and maintenance workers been trained in how and under what circumstances guards can be removed? ____ ____
4. Have workers been trained in the procedures to follow if they notice guards that are damaged, missing, or inadequate? ____ ____

## Protective Equipment and Proper Clothing

1. Is protective equipment required? ____ ____
2. If protective equipment is required, is it appropriate for the job, in good condition, kept clean and sanitary, and stored carefully when not in use? ____ ____
3. Is the operator dressed safely for the job (i.e., no loose-fitting clothing or jewelry)? ____ ____

**Yes** **No**

**Machinery Maintenance and Repair**

1. Have maintenance workers received up-to-date instruction on the machines they service? ____ ____
2. Do maintenance workers lock out the machine from its power sources before beginning repairs? ____ ____
3. Where several maintenance persons work on the same machine, are multiple lockout devices used? ____ ____
4. Do maintenance persons use appropriate and safe equipment in their repair work? ____ ____
5. Is the maintenance equipment itself properly guarded? ____ ____
6. Are maintenance and servicing workers trained in the requirements of 29 CFR 1910.147, lockout/tagout hazard, and do the procedures for lockout/tagout exist **before** they attempt their tasks? ____ ____

## State Occupational Safety and Health Consultation Project

A source of assistance with construction and general industry safety and health is the Montana Onsite Consultation Project. This division of the Department of Labor and Industry operates independently of OSHA's enforcement branch. The program was developed with small businesses in mind, and is available to private sector employers who want help in recognizing and correcting jobsite hazards.

When an employer uses the service, a trained occupational safety and health professional conducts a free onsite "inspection" and consultation. No citations or penalties are given for any of the problems that the inspector/consultant may find, and the service is completely confidential. The employer has the responsibility and obligation through the program to correct the identified hazards within an allotted amount of time. In addition, the consultant can assist in developing and maintaining an effective safety program, offer jobsite training and education for employees, and help locate other sources of assistance for safety and health concerns.

Although this program can be beneficial, you must realize that there is still no guarantee that a jobsite that has received the consultation services will "pass" an OSHA inspection. For information about Montana's Onsite Consultation Project please contact:

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